

DEVIL'S GARDEN EXTERMINATION PROJECT
MODOC NATIONAL FOREST, CALIFORNIA

PROGRESS REPORT

by

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1931

Annex I

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PROCESS REPORT

Introduction

Information concerning the possibilities of complete extermination of the western pine beetle (Dendroctonus brevicornis Lec.) by control methods now in use, has been practically limited thus far to the results of several experiments carried on in 1924 and 1925. These experiments, known as the San Joaquin projects^{2,3}, were carried on by the U.S. Bureau of Entomology to study the flight of the western pine beetle from an uncontrolled area to an adjoining area that had been subjected to an intensive control operation.

Such areas as had undergone intensive control were readily reinfested the next season by beetles entering from the adjoining untreated areas. Though the beetles averaged only one-half to one and one-half miles in their flights, successive generations soon built up a new infestation throughout the stands on the areas, which were two to three miles in diameter. From these studies it was evident that effects of control were transient and of doubtful value where the treated area was small and adjacent to or within one or two miles of untreated timber.

The next attempt to study the flight habits of the western pine beetle was made in the Devil's Garden extermination experiment. Unlike previous studies, the area to be covered was isolated, and it was believed that the beetles could be exterminated much more successfully. If all infested trees on the isolated area were treated, any reinfestation would apparently have to come from the nearest pine stand, which, in the Devil's Garden area, was nearly six miles away. It then remained to be seen whether or not the beetles could cover this distance in sufficient quantity to cause a reinfestation on the treated area. With this in mind the Devil's Garden extermination project was begun in the fall of 1922.

Methods of Study

A small isolated area of western yellow pine was set aside in the Devil's Garden district of the Modoc National Forest as a possible location for the experiment. At the time this was begun, the plans called for a commercial control operation on the area for the first two years, followed by an intensive control operation the third year, in an effort to bring about a complete extermination of the beetles. "Commercial" control is that in which the treated timber represents but a fraction of the total seasonal infestation, or the largest amount of infested timber that can be economically treated. An "intensive" control operation is one in which as nearly as possible 100 per cent of the total seasonal infestation is treated. The experiment has been carried on by the U.S. Bureau of Entomology with the cooperation of the U.S. Forest Service.

*Numbers in parenthesis refer to bibliography.

Character of the Area

The area under observation is located in the Timbered Mountain Unit of the Devil's Garden District, Medoc National Forest. Timbered Mountain is a small knoll about four miles in length and three miles in width, rising slightly above the surrounding Devil's Garden plateau. There are approximately 500 acres of virgin yellow pine timber on the higher levels of the mountain. This timber, which is of Site 4 quality and runs about 8,000 board feet per acre, is shown in Photo No. 1. Surrounding this heavier stand is an area of 800 acres, containing about 3,000 board feet of yellow pine to the acre. Extending from this area for about a mile in all directions is a very open, scattered stand of pine and juniper, not exceeding one yellow pine tree to the acre (Photo No. 2). The entire mountain is surrounded by a high plateau containing a pure stand of juniper, with only an occasional pine tree. This fringe type is illustrated in Photo No. 3.

When the area was first located in 1928, it was believed to be six miles from the nearest yellow pine stand, with the exception of a few scattered single yellow pines. In 1930 Person⁽⁴⁾ mapped the area surrounding Timbered Mountain and found that "the distance between the northernmost trees of the extermination area and the southernmost trees of the Blue Mountain unit to the northwest is only two miles in two different places. The yellow pine type limits for the two areas are about 3½ or 4 miles apart, but occasional trees scattered between the two areas leave only a very small gap."

The accompanying map illustrates the position of the Timbered Mountain isolated area in relation to the surrounding yellow pine stands. From this it can be seen that the area is not as completely isolated as was at first believed.

History of the Stand

In 1928 the pine stand on Timbered Mountain was estimated at 10,000 M.B.M. on a total area of 5,400 acres, all of which was national forest land. The stand is a Site 4 and overmature, very little increment having been added in the last few decades. Reproduction is very poor over the area as a whole, though small patches of good reproduction occur at widely-scattered intervals (Photo No. 5). The ground cover, shown in Photo No. 4, consists primarily of a heavy growth of mountain mahogany (*Cercocarpus ledifolius* Nutt.) and common sage (*Artemisia tridentata* Nutt.).

An examination of the area by Keen in 1928 showed that approximately 10 per cent of the stand had been killed by the western pine beetle in the few years prior to 1927. The heaviest loss occurred in 1926, when the peak of an epidemic apparently was reached.

Eight cruises of the area have been made, as follows:

1928 - September
1929 - April, June, August, October
1930 - May, August
1931 - May

Commercial control operations have been carried on in conjunction with all cruises except the first. While it was originally intended to follow the first two years' commercial control operations with an intensive control program the third year, this was not done, and to date no intensive control has been carried on. However, the control operation carried on in May, 1931, has been of a more intensive nature than the average commercial control operation.

Volume of Timber Infested and Treated

Since the extermination study was begun, control has been carried on chiefly for the winter brood except in 1927, when no control work was done. This has left the summer brood practically free of any definite control measures. The regular control on the project area has been carried on in the spring, so that a few early summer trees have been included; hence control figures show both summer and winter trees as having been treated. A small amount of summer control was carried out during the summer of 1929, which accounts for the slight increase in the number of summer trees treated in that year.

The infested and treated trees on the area since 1927 are shown in Table I.

TABLE I
Volume of Timber Infested and Treated, Devil's Garden Project

Year and Season	Infested		Treated	
	No. Trees	Volume	No. Trees	Volume
1927 Summer	34	44,960		
Winter	31	32,850		
1928 Summer	15	15,640		
Winter	45	48,420	33	34,980
1929 Summer (standing)	14	14,750	4	3,390
" (trap trs.)	4	9,930	4	9,930
Winter	20	21,800	20	21,800
1930 Summer (standing)	6	4,230	2	1,460
" (trap trs.)	4	3,700	3	2,520
Winter	47	42,060	40	35,460
1931 Summer (incomplete)	4	2,240	4	2,240

No topkills included

A graphic representation of the above data is given in Fig. 1.

The inclusion of trap trees during the summers of 1929 and 1930 is somewhat confusing. Salmon⁽⁵⁾ has shown that there is a marked irregularity in the infestation curve when the numbers and volumes of infested trees are based upon insect generations. This irregularity is more pronounced when the trap trees are left out of consideration. However, in an extermination project of this nature the infested trap trees must be included, since they are an important source of infestation.

A comparison of the Devil's Garden Extermination Area with the Happy Camp-Lava Bed Area is shown in Table II. This table is based on yearly losses rather than on insect generations, and a smoother curve (Fig. 2) results. The Happy Camp-Lava Bed Area represents some 376,000 acres, including most of the timber types common to the Modoc country. No control has been carried on in this area during the time of the Devil's Garden study except in one instance.

TABLE II
Comparison of Volume of Timber Infested in Devil's Garden Project
with Total Volume of Insect Loss on Happy Camp-Lava Bed Area
(based on 1927 data)

Season	Devil's Garden		Happy Camp-Lava Beds	
	Volume B.M.	% Decrease	Volume B.M.	% Decrease
1927	77,810	0.0	183,900	0.0
1928	64,120	17.6	134,000	27.1
1929	46,480	40.3	49,000	73.9
1930	49,980	35.8	33,740	81.7
1931*	2,240	97.2	73,730	59.8
Totals	240,640		473,370	

*Incomplete

A control operation was carried on in the Badger Unit of the Happy Camp-Lava Bed area in 1928. Keen⁽¹⁾ reports that the 1929 survey of the Badger Unit showed a decreased infestation of 90 per cent, while the remainder of the Happy Camp-Lava Bed area showed a decreased infestation of 78 per cent over the previous year. The figures used in Table II for the Happy Camp-Lava Bed area include the Badger Unit. However, since the one control operation represented only 18 per cent of the entire area, and the natural decrease in the infestation was so great during 1928-29, it may be considered that the control project had little effect on the area as a whole.

Therefore, in comparing the Devil's Garden extermination area with the Happy Camp-Lava Bed check area, it may be seen that the decrease in losses for the latter area is greater than in the former area, where control has been carried on against five broods of the western pine beetle. From this it is apparent that control work has had little effect in reducing insect losses on the Devil's Garden area. A possible explanation of this lies in the fact that this area represents extremely poor growing conditions, and that owing to this a true comparison of the two areas cannot be made.

Bark Area Infested

In studying the insect population of infested trees, the only true index is the number of square feet of bark actually infested. Since the winter of 1928 records have been taken of the bark of infested trees showing the amount of green, infested and abandoned bark, and also the amount of bark infested by each species of insect. These data are secured by means of a stem analysis of the felled trees during control operations. Table III compares the uninfested, infested and abandoned bark areas of the infested trees to date. No topkilled trees are included.

TABLE III
Comparison of Infested, Uninfested and Abandoned Bark Areas

Year and Season	No. of Records	Green Bark Sq. Ft.	%	Inf. Bark Sq. Ft.	%	Abandoned Bk. Sq. Ft.	%	Total Sq. Ft.	%
1928-W	33	—	0	8,293:87.0	1,216	13.0		9,509:100	
1929-S	4	—	0	1,422:98.7	18	1.3		1,440:100	
Trap Trees:									
1929-S	4	542	25.6	1,156:54.5	421	19.9		2,119:100	
Total									
1929-S	8	542	15.2	2,578:72.5	439	12.3		3,559:100	
1929-W	14	120	2.0	5,248:88.8	556	9.4		5,924:100	
1930-S	3	—	0	812:82.1	178	17.9		990:100	
Trap Trees:									
1930-S	3	—	0	657:74.9	221	25.1		878:100	
Total									
1930-S	6	—	0	1,469:78.6	399	21.4		1,869:100	
1930-W	40	1,618	7.9	11,254:87.8	551	4.3		12,818:100	
1931-S	4	81	7.5	997:92.5	—	0		1,078:100	

From the above table it appears that the winter broods have infested a much greater bark area than the summer broods. It must be kept in mind, however, that very little control work has been done on the summer broods, and that only a few summer trees have been included in the spring control operations. From the bark area records taken since the winter brood of 1928, it has been possible to determine fairly accurately the amount of infested bark surface attributable to each of the six major bark beetles found on the area. In Table IV (also Fig. 3) the area and per cent of bark infested by each species are shown.

TABLE IV
Comparison of Bark Areas Infested by Different Species of Insects

Year and Season	No. of Records	D. brev. Sq. Ft.	D. brev. %	D. mont. Sq. Ft.	D. mont. %	D. valens Sq. Ft.	D. valens %	Melanophila sp. Sq. Ft.	Melanophila sp. %	Ips. emarg. Sq. Ft.	Ips. emarg. %	Ips. oreg. Sq. Ft.	Ips. oreg. %	Total Sq. Ft.	Total %
1928-W	33	5,329	63.7	483	8.2	13	0.1	1,916	18.1	379	4.8	173	2.1	8,293	100
1929-S	4	1,016	71.7	18	1.1	-	0	51	3.6	276	19.5	59	4.1	1,422	100
Trap Trees:															
1929-S	4	753	63.4	54	4.7	36	3.1	169	14.6	110	9.5	54	4.7	1,156	100
1929-S															
Total	8	1,751	67.9	72	2.8	36	1.4	220	8.5	386	5.0	113	4.4	2,578	100
1929-W	14	2,200	41.9	370	7.1	42	0.8	2,084	39.7	320	6.1	232	4.4	5,248	100
1930-S	3	372	45.9	88	10.8	-	0	298	36.7	-	0	54	6.6	812	100
Trap Trees:															
1930-S	3	417	63.5	-	0	-	0	240	36.5	-	0	-	0	657	100
Total															
1930-S	6	789	53.7	88	6.0	-	0	538	36.6	-	0	54	3.7	1,469	100
1930-W	40	3,129	27.8	416	3.7	113	1.0	6,336	56.5	990	8.8	270	2.4	11,254	100
1931-S	4	324	32.5	137	13.7	13	1.3	435	43.7	25	2.5	63	6.3	997	100
Total	119	16,062	47.5	1,726	5.2	133	0.7	12,257	36.1	2,436	7.3	1,072	3.2	33,856	100

The western pine beetle (Dendroctonus brevicornis Lec.) has been by far the most important bark beetle on the area. However, since the 1928 winter brood the flathead beetles (Melanophila spp.) have increased to such proportions that the bark area infested by D.brevicornis was less than one-half that infested by flathead beetles in the winter of 1930. This may be explained by the poor timber-growing conditions of the Devil's Garden area and by the prolonged dry spell which the region has experienced. These conditions are favorable to the development of flathead borers. Control work also eliminated a smaller percentage of flatheads than D.brevicornis.

The four other species of insects recorded have shown a fairly constant rate throughout the period of the experiment, and an average of less than 10 per cent of the infested bark area can be attributed to them. These lesser species include the large western pine engraver beetle (Ips emarginatus Lec.), the Oregon pine engraver beetle (Ips oregoni Eich.), the mountain pine beetle (Dendroctonus monticolae Hopk.) and the red turpentine beetle (Dendroctonus valens Lec.).

From the percentage of bark area killed by each species on treated trees a table (Table V) has been worked out, showing the percentage of bark area killed by each species for the total number of infested trees for each season on the area.

TABLE V
Computed Totals of Infested Bark Areas

Season:	No. : Aver.B.A. :		No. : Tot.B.A. :		Infested Trees							
	Tr. : per Tr. :		: Inf. : Inf.Tr. :		D.brev. Melan.spp. Misc. Insects							
	: Trees: Tree, sq.ft. :		: Trs. : Sq.Ft. :		: Sq.Ft. : % : Sq.Ft. : % : Sq.Ft. : %							
1928-W	23	236	45	10,620	7,296	68.7	1,922	18.1	1,402	13.2		
1929-S	8	322	13	5,796	3,935	67.9	493	8.5	1,363	23.6		
1929-W	14	375	20	7,500	3,143	41.9	2,978	39.7	1,379	18.4		
1930-S	6	245	10	2,450	1,316	53.7	697	36.6	237	9.7		
1930-W	40	281	49	13,769	3,328	27.3	7,752	56.3	2,189	15.9		
1931-S*	4	249	4	997	324	32.5	435	43.6	239	23.9		

*Incomplete

Fig. 4 shows the same data graphically.

The above table gives the entire insect loss on the Devil's Garden Extermination Area for the major insect species since the winter of 1928, based upon bark area. There has been a steady decrease in the total infested bark area up to the 1930 winter brood. A heavy increase is noted for the latter, and from all indications this increase will continue through the 1931 season. The figures for 1931 are incomplete, and cannot be used at present for predicting any future trends in the insect infestation for the area.

Conclusions

It appears that the control work done to date in the project area has had little effect on the infestation. While a very good commercial control program has been carried out, the beetles left have evidently been abundant enough to keep the infestation from being entirely wiped out.

It is becoming apparent that complete extermination of the western pine beetle is practically impossible, using the control methods now in force. Many "green" trees on the project area evidently harbor small broods of the western pine beetle. Since these broods are evidently too small to cause any outward signs of their presence, such trees often pass unnoticed by the spotters, with the result that the beetles are left on the area after control. With the advent of favorable conditions these small broods may spring into prominence. Complete extermination would then mean the cutting of all such green trees showing the least sign of insect attack, and some that did not show such signs. The heavy expense, the time consumed, and poor market for salvaged timber would not warrant such measures, and in an area such as the Devil's Garden few green trees would be left.

The entire study of three years is in reality too brief to permit any definite conclusions to be drawn. Brief as it has been, it has brought out some good points, such as the changing of the infestation from the western pine beetle to the flathead type. During the study there has been a natural decrease in the infestation, and it will be interesting to note the result of control on an increasing infestation, as is evidently the case at present.

Another feature of the 1931 infestation in the Devil's Garden is the type of tree attacked. The D. brevicornis infestation was very weak, and was confined principally to the lower portions of trees previously topkilled by flathead beetles or other species. A typical 1931 brood tree is shown in Photo No. 6.

Summary

Since the experiment is still being conducted, it is impossible to draw any final conclusions from the data to date. Several indications have thus far been brought out in the study, as follows:

1. A sharp increase in the infestation began with the 1930 winter brood, and apparently greater increases are to be expected;
2. The annual volume of infested timber in the project area has decreased rapidly until the 1930 winter season, where a sharp increase is noted;
3. The infestation decreased at a slower rate in the project area than in the untreated areas in the same general region;

4. The increase in the 1930 winter brood was heavier in the untreated areas than in the treated project area;

5. The western pine beetle has decreased in relative importance on the project area, while the flathead borers have increased, the importance being based on the bark area infested by each;

6. The 1931 D.b. attack was confined largely to the lower portions of trees previously topkilled by flathead beetles and other species .

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Photo No. 1. Tree No. 30-6 being treated by the burning method. This illustrates the best pine type on the Devil's Garden Area.



Photo No. 2. Scattered yellow pine-juniper type on the Devil's Garden Area.

Photo No. 3. Juniper-yellow pine type forming outer fringe
of the Devil's Garden Area



Photo No. 4. Tree No. 30-7 (left). Typical mountain mahog-
any underbrush and scattered yellow pine type.

Photo No. 5. One of the best stands of reproduction on the Devil's Garden Area.

Photo No. 6. Tree 30-7 (left). Typical mixed-brood tree on Devil's Garden Area. Top previously killed and lower stem being filled in by current attack.



VOLUME OF TIMBER INFESTED AND TREATED

Standing Timber Infested
 Trap Trees Infested
 Standing Timber Treated
 Trap Trees Treated

M.B.M.

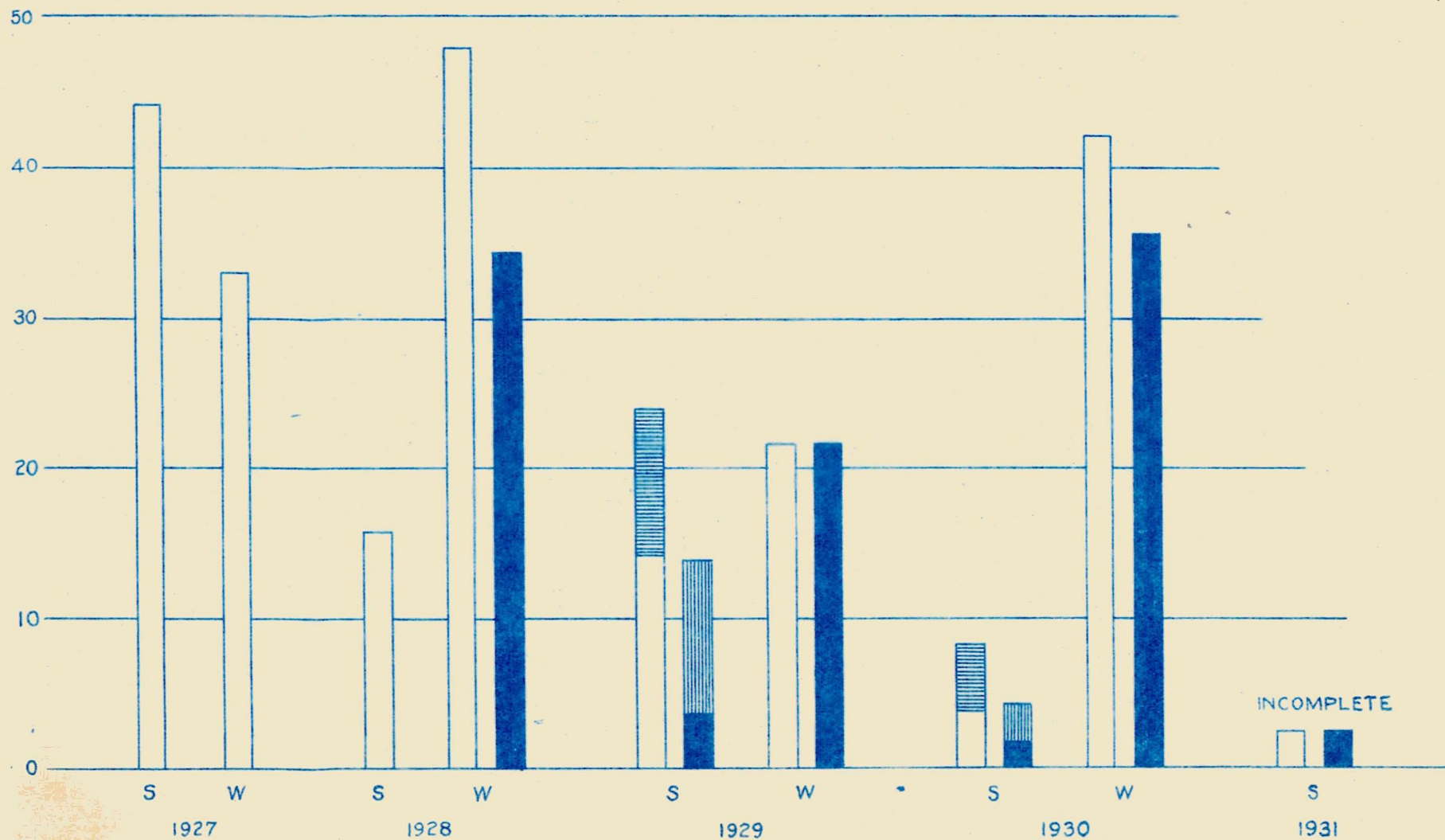
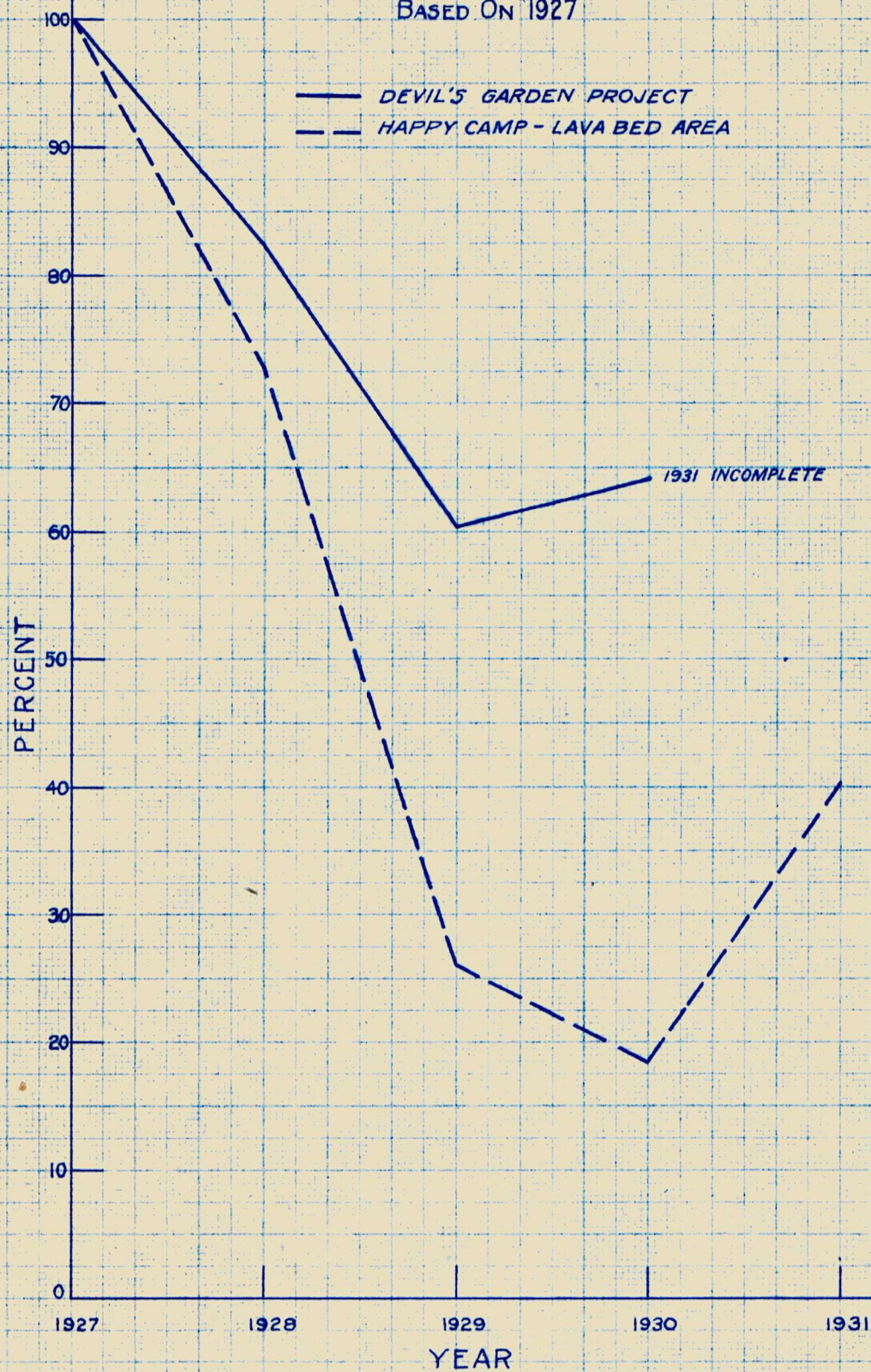


FIG. 1

FIG. 2

INFESTATION CURVES

BASED ON 1927



PERCENT OF BARK AREA INFESTED - BY SPECIES

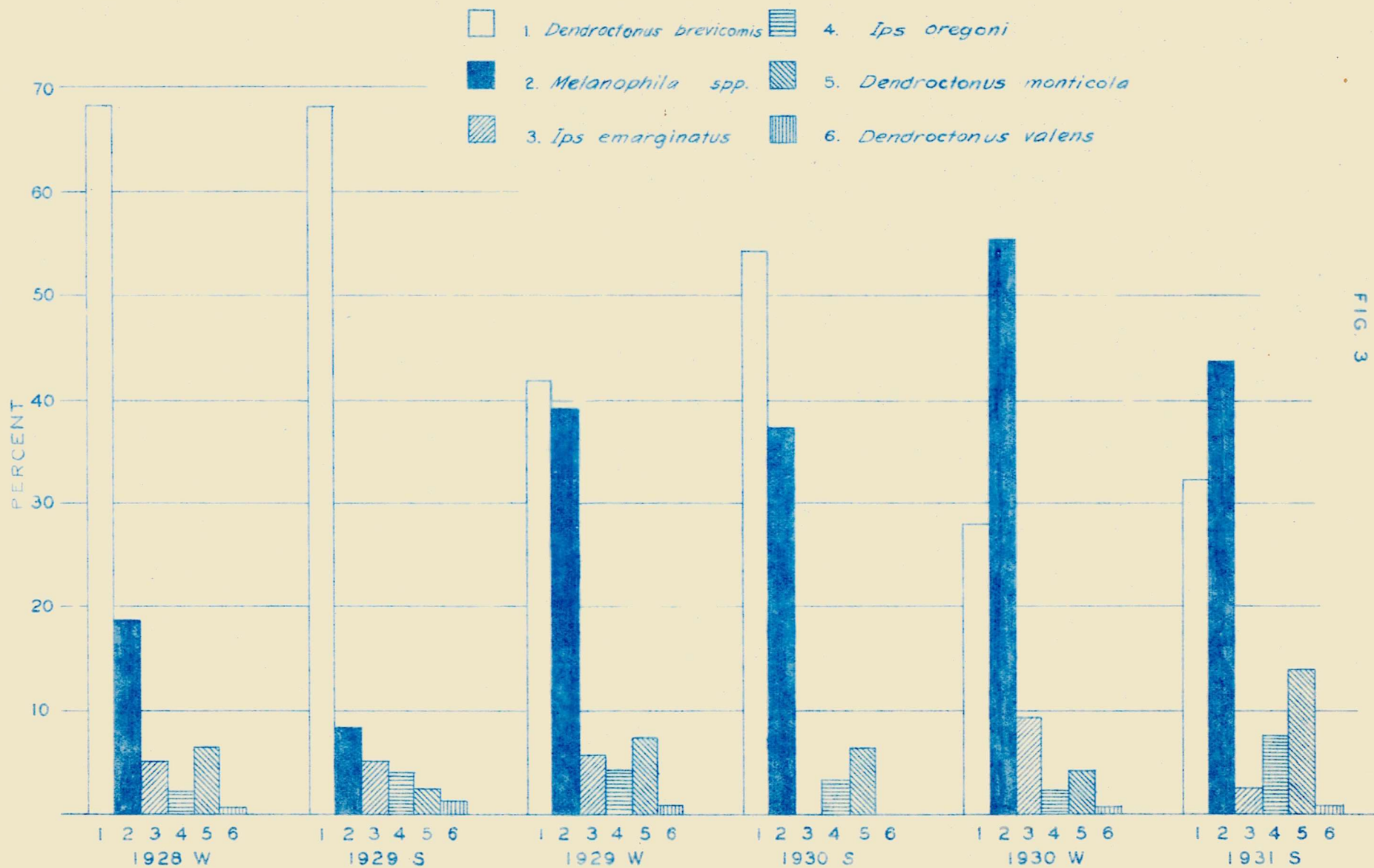
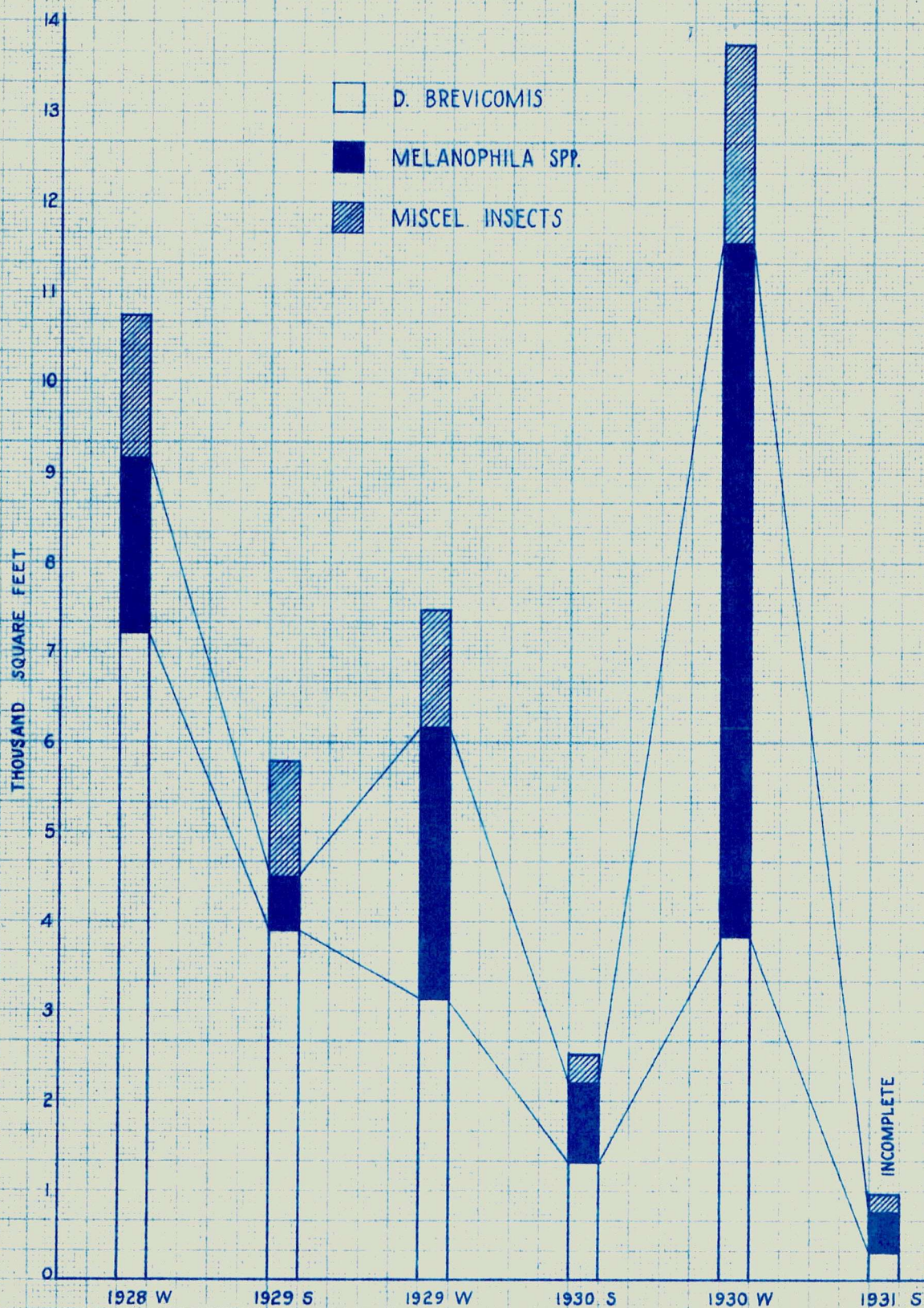


FIG. 3

FIG. 4

INFESTED BARK AREA

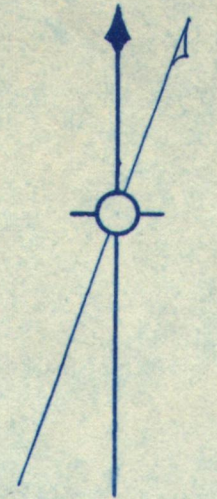


BUREAU OF ENTOMOLOGY
DEVIL'S GARDEN EXPERIMENTAL AREA
MODOC NATIONAL FOREST, CALIFORNIA

SCALE: 1 INCH = 1 MILE

LEGEND

- Isolated Yellow Pine Trees
Yellow Pine Type
Timber Boundary



R 10 E

R 11 E

R 12 E

T 46 N

T 46 N

T 45 N

T 45 N

